WILDLIFE HABITAT RELATIONSHIPS
IN WASHINGTON AND OREGON
FY2013

1. Title: Final Report: Demographic characteristics of northern spotted owls (*Strix occidentalis*) on the Tyee Density Study Area, Roseburg, Oregon: 1985–2013.

2. Principal Investigator(s) and Organization(s): Dr. E. D. Forsman (PI), J. A. Reid (Assistant PI), U. S. Forest Service, Pacific Northwest Research Station. Biologists: J. Francoeur, S. Sabin, and S. Smith, Department of Fisheries and Wildlife, Oregon State University.

3. Study Objectives:

a. Elucidate the population ecology of the spotted owl on the Tyee Density Study Area, northwest of Roseburg, Oregon to include estimates of population age structure, reproductive rates, survival rates, and population trends.

b. Document trends in numbers of spotted owls in a bounded study area.

c. Document social integration of juveniles into the territorial population to include age at pair formation and age at first breeding.

d. Document trends in barred owl numbers and interactions with spotted owls.

4. Potential Benefit or Utility of the Study:

The Tyee Density Study Area (DSA) on the Roseburg District of the Bureau of Land Management was designed to monitor age-specific birth and death rates of northern spotted owls, thereby allowing estimates of population trend over time. From these trends we make inferences regarding the suitability of the current habitat conditions and the effects of different landscape conditions on spotted owls. This study was one of eight long-term demographic studies that constitute the federal monitoring program for the northern spotted owl (Lint et. al., 1999, Anthony et. al., 2006, Forsman et al., 2011).

Management of forest lands by the BLM and private landowners within the boundaries of the DSA led to a reduction of suitable owl habitat during the last 40–50 years (Thomas et al. 1993). Although rates of harvest on BLM lands declined substantially since the adoption of the Northwest Forest Plan (USDA and USDI, 1994), there was an increased emphasis on thinning stands on federal lands, and harvest of old forests on non-federal lands continued. The effects of thinning within close proximity to owl sites is, as of yet, uncertain, although there was evidence that thinning in young stands in Washington caused reductions in the density of northern flying squirrels (Wilson, 2010), which are an important prey of spotted owls in the Tyee Density Study Area (Forsman et al. 2004). Although habitat is still an important factor contributing to population stability of spotted owls, other factors such as climate change, increasing numbers of barred owls, and new pathogens such as West Nile Virus may also affect the numbers of spotted owls in the study area. While the data collected during this study cannot be used to predict future conditions, they can be used to assess predictive models that examine population projections under varying landscape conditions or management regimes (Forsman et al., 2011).

We attempted to band all known fledglings produced in the study area since 1985. As a result, we know the origin and age of most individuals that were recruited into the population, and have detailed information on population age structure and internal and external recruitment in the study area.

5. Research Accomplishments:

Study Area and Methods

The Tyee Density Study Area (DSA) northwest of Roseburg, Oregon included a mixture of federal lands administered by the Bureau of Land Management (BLM) interspersed in a checkerboard pattern with intervening sections of private land (Fig. 1). Total size of the study area was approximately 1,025 km^2 (253,280 acres). We also monitor known spotted owl territories within a 6-mile buffer area outside the eastern and western boundaries of the DSA to reduce the amount of unknown emigration from the DSA (Reid et al. 1996). The study area included all or part of 4 Late-Successional Reserves (LSR's) as identified in the Northwest Forest Plan land-use allocations (USDA and USDI, 1994).

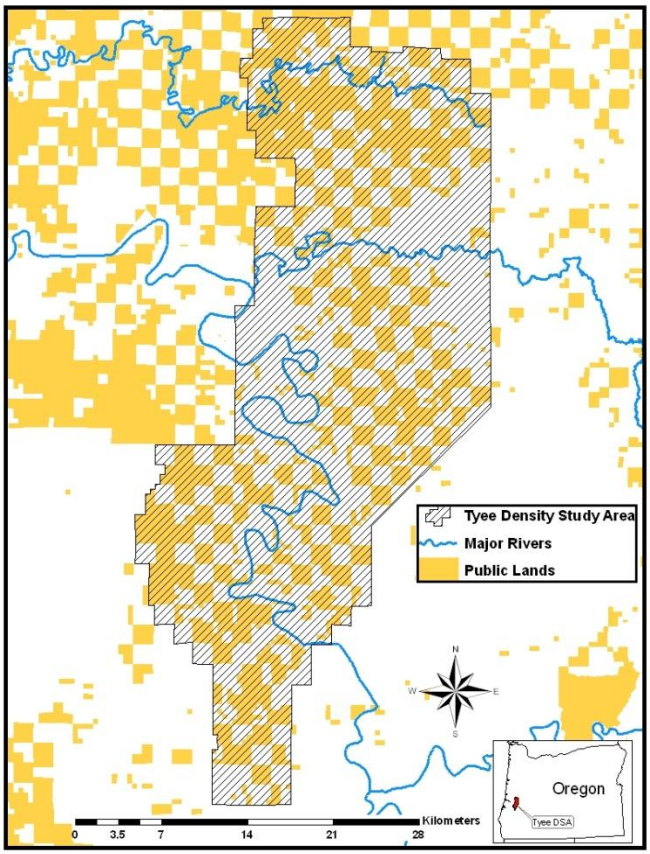

Figure 1. The hatched area represents the Tyee Density Study Area (DSA), Roseburg, Oregon.

Banding was initiated on the study area in 1983 and increased substantially in 1985. Surveys increased in 1987 to include all suitable spotted owl habitat. In 1989, the study area was expanded to include the upper third portion of the present area (Fig. 1). In 1990, we initiated the method in which we survey the entire study area each year (density study). Based on these surveys we estimate the actual number of territorial owls. The number of survey polygons within the DSA (160) remained relatively constant among years and was determined by the location of historical spotted owl site centers. The size of each survey polygon varies, depending on topography and land ownership, but was roughly equal to the area of a spotted owl territory. Areas between known spotted owl territories were delineated for survey depending on topography, road access, and distance from known spotted owl sites. In all surveys we document spotted owls as well as all other owls that were seen or heard.

Methods used in this study and other demographic studies of spotted owls have been described in a variety of published sources (e.g., Forsman 1983, Franklin et al. 1990, Franklin 1992, Franklin et al. 1999, Lint et al. 1999). Seemingly unoccupied areas were surveyed with a minimum of 3 complete night visits spaced throughout the main survey season (1 March-31 August; Reid et. al, 1999). Resightings and recaptures of previously banded owls were used to estimate survival rates (Forsman et al. 2011).

Numbers of owls detected on the DSA

Between March 1983 and August 2013, we banded 960 spotted owls on the DSA, including 681 juveniles, 95 subadults, and 184 adults. The sex ratio of adults in the banded sample was slightly skewed towards males. By comparison, the sex ratio of subadults was skewed toward females (Appendix 1). The disproportionate number of males in the adult sample was most likely because males, especially unpaired males, were more detectable than females (Reid et al.1999).

In 2013, we documented 73 non-juvenile spotted owls in the DSA, including 29 pairs and 15 unpaired individuals (Appendix 2). This represents approximately 51% of the number of individuals that were

located during the first year of the study in 1990 and was the lowest number of owls detected since inception of the study (Fig. 2).

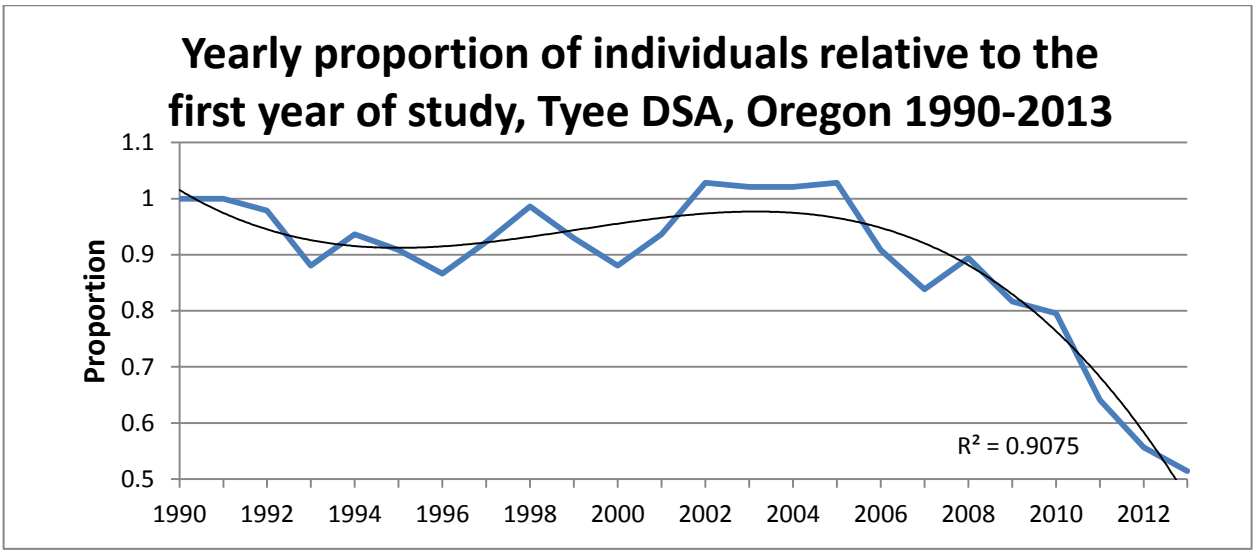

Figure 2. Yearly proportion of non-juvenile spotted owls detected relative to the first year of study, Tyee Density Study Area (DSA), Roseburg, Oregon, 1990-2013.

Within the DSA we documented 20 individuals that moved from their previous territory to another in 2013. Of the owls that moved, all were non-juveniles and already been a part of the territorial population (i.e. no new recruits). The trend was increasing and linear (Fig. 3). We suspect that this increasing trend in the annual rate of movement among territories may be a response to competition with barred owls which were increasing on the Study Area (Fig. 4) (Yakulic, et. al. 2012).

Number of sites with spotted owls

We defined a site as an area where a pair of spotted owls was documented in at least one year in the study and defined a pair as 2 individuals of opposite sex that clearly associated during the survey year. The number of sites with pairs declined rapidly after 2005 and had not recovered (Appendix. 2). In 2013, the number of pairs and the total number of non-juvenile spotted owls detected was below average for the 24 year survey period (Appendix 2, Fig. 2). In 2013, approximately 76% of the pairs (N=29) and 80% of the nesting pairs (N=5) in the DSA were located on federal land and 20% were on private land.

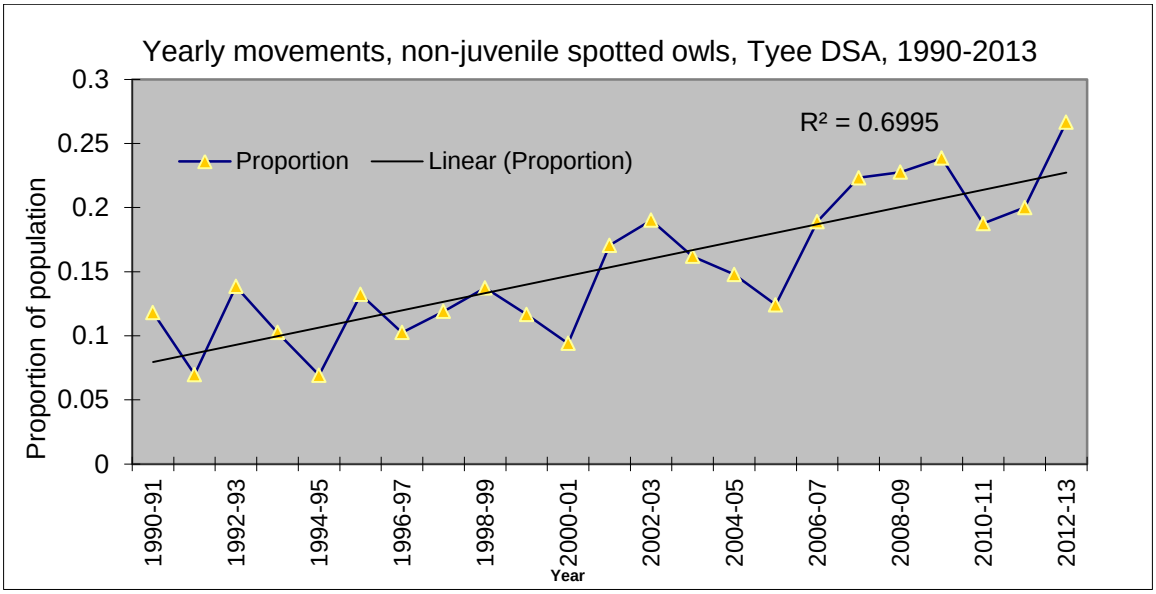

Figure 3. Yearly proportion of non-juvenile spotted owls known to have moved between territories on the Tyee Density Study Area, Roseburg, OR, 1990-2013.

Barred Owls

We documented barred owl detections since the inception of the study. Although we do not survey for barred owls, our methods for spotted owl surveys enabled us to estimate general trends in the barred owl population. The DSA was consistently surveyed in terms of area, intensity, and methods since 1990. In 2013, the number of survey areas where we detected barred owls continued to exceed the number of survey areas where we detected spotted owls (Fig. 4). The estimate of barred owls was considered conservative since we did not survey specifically for barred owls, and it was likely that some barred owls were not detected (Wiens et. al., 2011).

Although the majority of spotted owls were uniquely identified, the identity (band confirmation) of some of the spotted owls that were detected remained unknown and could have been individuals already identified during the survey season. The same circumstances applied to the barred owls, where most barred owls were unbanded and it was therefore impossible to confirm their unique identity. The number of areas where barred or spotted owls were detected consisted of any barred owl or spotted owl, regardless of identity (Fig. 4).

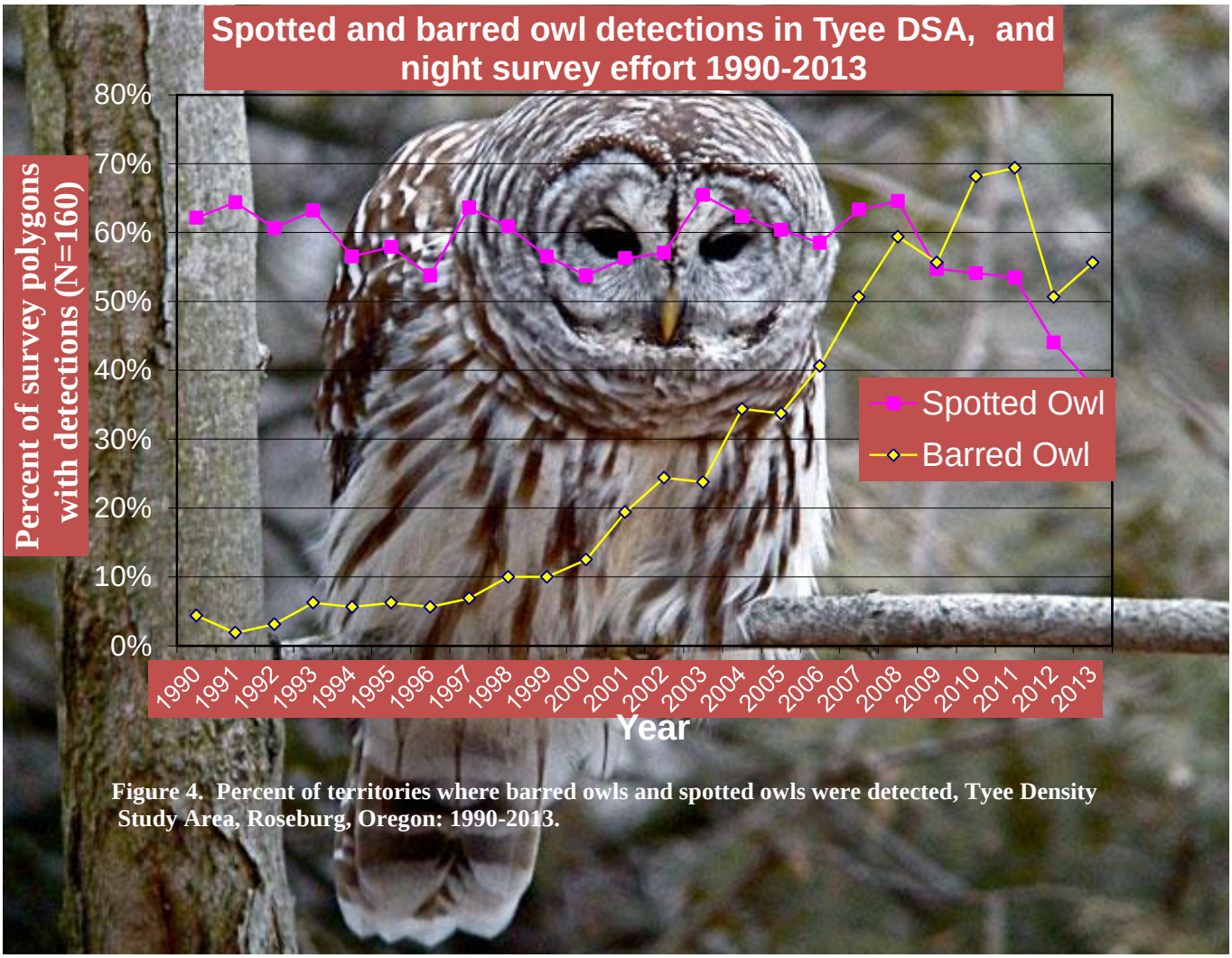

Figure 4. Percent of territories where barred owls and spotted owls were detected, Tyee Density Study Area, Roseburg, Oregon: 1990-2013.

Movements

There appears to be downward trend in the number of territories where spotted owls were detected (Fig. 4). As the yearly number of individuals moving to different sites increased (Fig. 3), confirmations of individuals at more than one site in the same survey season also increased (Fig. 5), leading to a bias of higher site occupancy for spotted owls. However, barred owls are not banded and the same bias may apply to barred owls as well. Causes for the linear increase in multiple observations could have included increased loss of spotted owl habitat (Kennedy et. al. 2010) leading to larger home ranges (Carey et. al., 1990), and barred owl interactions (Dugger et. al., 2011, Van Lanen et. al., 2011, Yackulic, 2012)

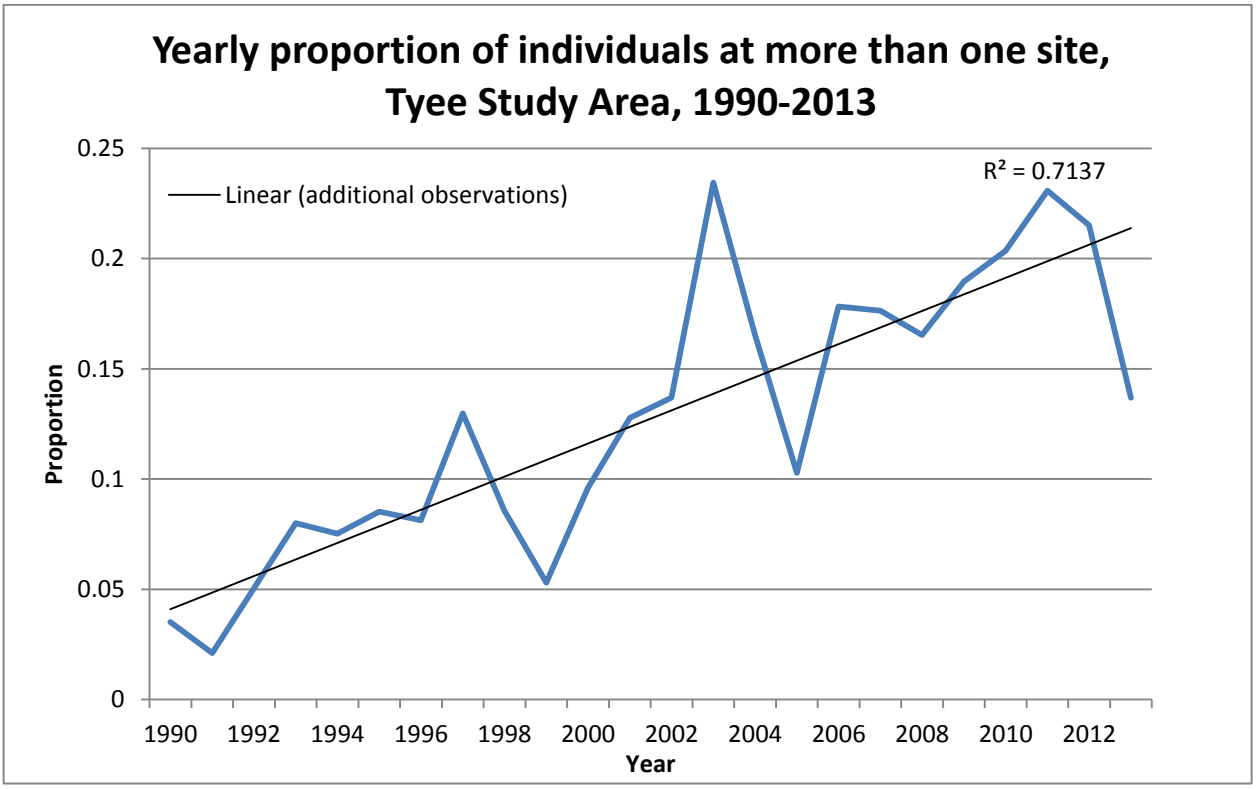

Figure 5. Proportion of spotted owls documented at more than one site during the same survey season, Tyee Density Study Area, Roseburg, Oregon: 1990-2013.

Reproduction

Although proportion of females nesting in 2013 was higher than the previous year, (0.20, 95% CI = 0.41-0.36), the number of females actually nesting has severely declined in the last 5 years and remains low as the population of spotted owls is in steep decline (Figure 2). Four out of the 5 nests this year successfully produced young (Table 1). For all years combined, the percentage of females that nested averaged 49% (N= 24 years) and the percentage of nesting females that fledged young averaged 66% (Table 1).

Average female fecundity (the estimated number of female offspring produced per resident female) in 2013 was 0.103 (SE = 0.05), which was considerably lower than the average of 0.242 for all years (N=24) (Appendix 3). The data continued to indicate that most measures of reproductive performance of spotted owls were lowest for 1-yr-old owls, intermediate for 2-yr-old owls, and highest for adults (Tables 2–3). Sample size of 1-yr-old females was too small to estimate some parameters (Table 2–3).

Banding juvenile owls can give us insight into first year survival, average and maximum lifespan, genealogy, dispersal distances, and age composition of the population (e.g., see Forsman et al. 2002). It

can also provide insight into the origin of new recruits as well as the individual territory productivity. We attempted to band all known fledglings in the DSA since 1985. Only 7 young were produced in the study area in 2013. Reproduction in the each of the last 8 years was below the 24 year average of 27.9 (Appendix 2) and may have been related to the exponential increase in the number of barred owls in the study area (Fig. 6).

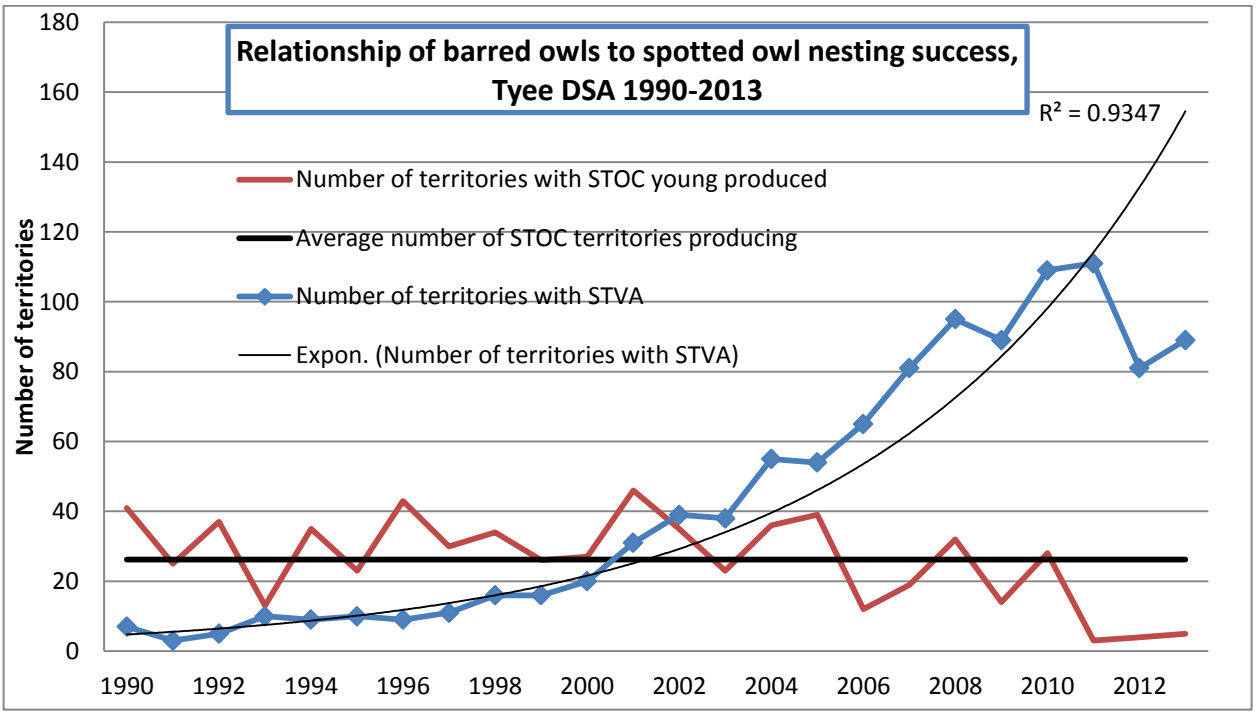

Figure 6. Yearly number of survey polygons in the Tyee DSA where barred owls were detected and where spotted owl reproduction was documented, 1990-2013.

2014 Meta-analysis

An extensive analysis of spotted owl data across the range of the species was conducted in January of 2014. Results from that analysis are being compiled. The preliminary yearly estimates from the best lambda (Forsman et al, 2011) model indicates a declining population for the Tyee DSA tracks closely to our estimates we generate using the numbers of individuals detected on the study area (Appendix 5).

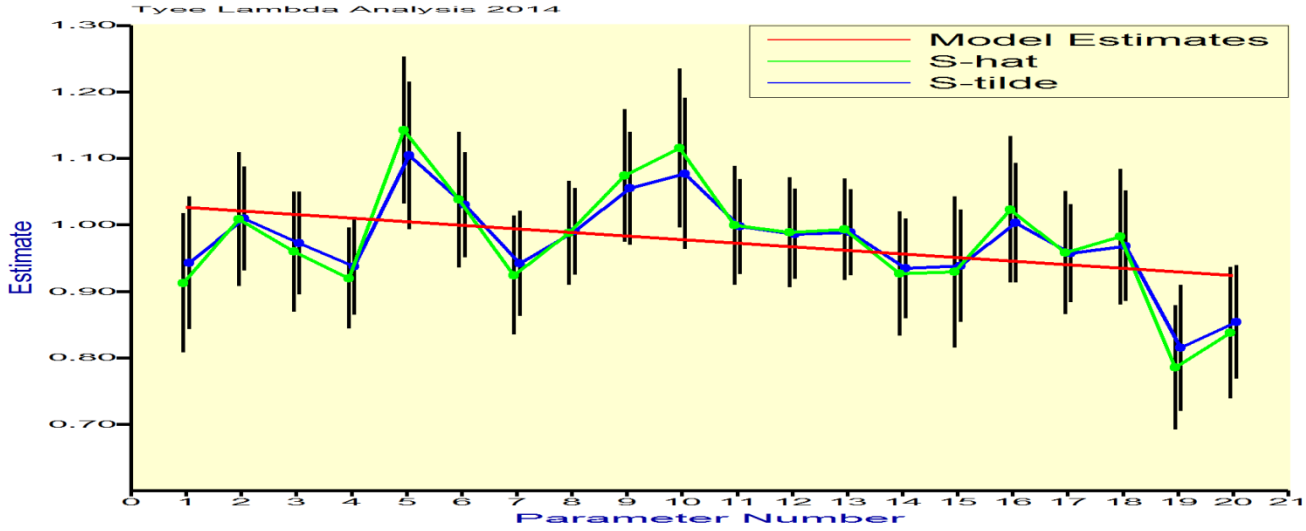

Figure 7. Output and preliminary model estimates from the 2014 meta-analysis indicating that the population of spotted owls in the Tyee DSA has been declining overall.

Table 1. Annual reproductive statistics for female spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2013.

	Proportion nesting [1]			Proportion fledging young [2]			Proportion nesting that fledged young [3]		
Year	**N**	**Prop.**	**95% C.I.**	**N**	**Prop.**	**95% C.I.**	**N**	**Prop.**	**95% C.I.**
1990	53	0.736	0.61–0.86	61	0.475	0.35–0.60	41	0.707	0.56–0.85
1991	56	0.446	0.31–0.58	59	0.237	0.13–0.35	25	0.560	0.35–0.77
1992	58	0.603	0.47–0.73	62	0.484	0.36–0.61	37	0.811	0.68–0.94
1993	47	0.255	0.13–0.38	54	0.130	0.04–0.22	13	0.538	0.22–0.85
1994	57	0.579	0.45–0.71	60	0.383	0.26–0.51	35	0.657	0.49–0.82
1995	53	0.415	0.28–0.55	60	0.200	0.10–0.30	23	0.522	0.30–0.74
1996	48	0.813	0.70–0.93	56	0.607	0.48–0.74	43	0.791	0.66–0.92
1997	51	0.588	0.45–0.73	55	0.327	0.20–0.46	30	0.600	0.41-0.79
1998	61	0.557	0.43–0.69	63	0.429	0.30–0.55	34	0.794	0.65–0.93
1999	45	0.556	0.40–0.71	55	0.327	0.20–0.46	26	0.692	0.51–0.88
2000	50	0.500	0.36–0.64	54	0.315	0.19–0.44	27	0.630	0.44–0.82
2001	54	0.796	0.69–0.91	61	0.639	0.52–0.76	46	0.848	0.74–0.96
2002	56	0.571	0.44–0.71	65	0.385	0.26–0.51	35	0.714	0.56–0.87
2003	58	0.379	0.25–0.51	67	0.194	0.10–0.29	23	0.565	0.35–0.78
2004	63	0.540	0.41–0.67	66	0.424	0.30–0.55	36	0.778	0.64–0.92
2005	61	0.639	0.52–0.76	66	0.439	0.32–0.56	39	0.744	0.60–0.89
2006	54	0.222	0.11-0.34	57	0.140	0.05-0.23	12	0.667	0.35-0.98
2007	44	0.432	0.28-0.58	48	0.292	0.16-0.43	19	0.737	0.52-0.95
2008	42	0.714	0.57-0.86	51	0.314	0.18-0.45	32	0.500	0.32-0.68
2009	41	0.317	0.17-0.47	45	0.178	0.06-0.29	14	0.571	0.27-0.87
2010	45	0.644	0.50-0.79	48	0.250	0.12-0.38	28	0.429	0.23-0.62
2011	31	0.129	0.00-0.25	37	0.027	0.00-0.08	3	0.333	0.00-1.00
2012	26	0.154	0.01-0.30	31	0.097	0.06-0.13	4	0.750	0.00-1.00
2013	25	0.200	0.04-0.36	29	0.138	0.01-0.27	5	0.800	0.00-0.67
Mean	N=24 years	**0.491**		N=24 years	**0.310**		N=24 years	**0.656**	

[1] Estimates were calculated for females whose nesting status was determined by protocol.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose reproductive status was determined to protocol and reproductive status by 31 August.

Table 2. Average age-specific reproductive parameters of female spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2013.

	Proportion nesting [1]			Proportion fledging young [2]			Proportion nesting that fledged young [3]		
Age	N	Prop.	95% C.I.	N	Prop.	95% C.I.	N	Prop.	95% C.I.
1 year old	56	0.160	0.06–0.26	70	0.029	0.00–0.07	8	0.250	0.00–0.64
2 years old	84	0.440	0.33–0.55	99	0.245	0.16–0.33	39	0.615	0.46–0.78
Adults	1008	0.549	0.52–0.58	1111	0.358	0.33–0.39	573	0.695	0.66–0.73
Unknown	11	0.545	0.23–0.85	21	0.240	0.02–0.45	11	0.455	0.15–0.76

[1] Estimates were calculated for females whose nesting status was determined to protocol.
[2] Estimates were calculated for females whose reproductive status was determined by 31 August.
[3] Estimates were calculated for females whose reproductive status was determined to protocol and reproductive status by 31 August.

Table 3. Average age-specific fecundity and brood size of female spotted owls on the Tyee Density Study Area, Roseburg, Oregon: 1990–2013.

		Fecundity [1]			Brood size[2]	
Age	N	Mean	SE	N	Mean	SE
1 year old	70	0.029	0.020	2	2.000	0
2 years old	10	0.204	0.038	24	1.667	0.098
Adults	1111	0.279	0.012	393	1.555	0.025
Unknown	21	0.167	0.072	5	1.400	0.245

[1] Fecundity was defined as number of female young produced per female. We assumed a 1:1 sex ratio for fledglings.
[2] Both fecundity and brood size were based on the number of young seen outside the nest tree, regardless of whether they were dead or alive.

Interesting observations and unusual events that were documented in 2013:

Problems encountered:

Hiring and training as well as the initial startup time and effort for new employees continues to decrease the amount of available time for our survey effort.

We also continue to have issues with deteriorating roads and blocked access from human activity, mostly logging equipment. Noise generated from these activities interferes with our survey results.

The decline in the numbers of spotted owls has led to an increased need in nocturnal surveys in the study area as more and more sites become vacant.

6. Summary

The number of spotted owls detected in the DSA continued to decline. When factors including habitat availability remain constant, the overall number of pairs in the study area was directly related to the previous reproductive output and can, therefore, be one of the more important metrics to assess future

population levels. Low reproductive years, or years with poor first year survival, can impact the future population size. In 2013, we documented 29 pairs of spotted owls in the study area. This was the same as the previous year and was the lowest number of pairs in the study area since the beginning of the study. (Appendices 2 and 4). Fecundity in 2013 was well below the average for all years combined. Average fecundity in the last 5 years has fallen below half what the average was in the previous 19 years of the study (Appendix 3). Future recruitment into the spotted owl population depends on the reproductive output of previous years. If this is any indication of the trend in future population, we can expect that the numbers of spotted owls recruited into the breeding population to decrease over time. Low reproductive output in the past several years suggests that the number of spotted owls will not increase substantially in the near future without an increase in reproduction. (Appendix 4).

The last 3 years of reproduction have been the lowest on record and resulted in the fewest number of young produced (Table 1). The low rate of nesting attempts may be due in part to the unfavorable weather conditions (Franklin et. al, 2000), but the decreasing number of pairs in the study area only compounds the effects of weather on reproductive output. Although harvest of older forest on Federal land has decreased, spotted owl sites are continuing to experience degrading habitat quality as more areas within the home range are thinned and private landowners continue to clearcut, even within the nest patch of successful spotted owl sites.

Barred owls almost certainly compete with spotted owls for both food and space (Hamer et al. 2007, 2001). Our study area recently experienced rapid increases in barred owl detections and it appears that this may be correlated with increased social instability, lower overall reproductive output, apparent abandonment of territories, and possibly lower detection rates of spotted owls (Bailey, et. al, 2009, Yakulic, et. al. *in review*). As habitat remains the same or decreases and barred owl numbers remain the same or increase, the spotted owl population will likely continue to experience declines.

7. Publications and Presentations:

a) We provided information to Ron Gaines, Environmental Services Northwest, and biological consultant for Lone Rock Timber Company.

b) We provided survey information to Eugene, Roseburg, and Coos Bay Districts of the BLM for the sites that we surveyed in their districts.

c) We provided spotted owl survey information to Oregon Department of Forestry.

d) We provided survey information to several landowners including Weyerhaeuser Company, Roseburg Resources, Seneca Jones Timber Company, and several other smaller landowners that granted us access to conduct surveys.

e) We provided feather samples for genetic analysis and datasets for pedigree analysis to the USGS genetics lab in Corvallis.

f) Publication: Charles Brandon Yackulic, Janice Reid, James D. Nichols, James E. Hines, Raymond Davis, and Eric Forsman In press. The roles of competition and habitat in the dynamics of populations and species distributions. Ecology.

g) We led a field outing for the Oregon Youth Conservation Corps to demonstrate the field techniques associated with spotted owl demography studies.

h) We attended a field outing and provided input into procedures associated with the Healthy Forest

Restoration Act and Safe Harbor Agreement on private land.

i) We provided a field outing and interview to the Envision online magazine.

j) We hosted an international couple studying the Forest Owlet in India. The couple spent several days learning about our research and observing the techniques. They were shown all aspects of the research project.

k) Conducted a campground presentation on biology of owls.

l) We provided data for spotted owl sites in Oregon to Erik Piikkila for analysis in association with railroad logging and historical fires.

m) We provided movement data to David Wiens of the USGS.

8. Acknowledgments

This study was funded by the USDI Bureau of Land Management Oregon State Office and the USDA Forest Service, Pacific Northwest Region. The Roseburg District of the BLM provided invaluable support in all phases of the research. We would like to thank the Weyerhaeuser Company, Roseburg Resources, Lone Rock and Juniper Properties, Seneca Timber Company, Giustina Resources, and Bear Creek Timber for allowing us access to their lands. Several small private landowners provided invaluable access through and to their property.

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Appendix 1. Number of previously unbanded spotted owls banded, Tyee Density Study Area, Roseburg, Oregon: 1990–2013.

	Adults		Subadults		Fledglings
Year	Male	Female	Male	Female	
<1990[1]	67	49	12	13	58
1990	14	7	4	7	31
1991	4	5	5	3	23
1992	3	6	2	3	44
1993	1	2	0	1	11
1994	0	2	2	2	28
1995	1	1	0	0	16
1996	1	0	0	0	53
1997	0	0	2	0	26
1998	1	0	1	2	34
1999	0	2	2	1	26
2000	1	1	1	0	28
2001	2	0	0	2	67
2002	2	1	1	4	40
2003	0	1	1	2	18
2004	1	2	0	1	37
2005	0	1	0	1	45
2006	2	0	2	0	10
2007	1	0	1	2	20
2008	1	1	2	2	27
2009	0	0	3	3	11
2010	0	0	1	1	15
2011	1	0	1	1	2
2012	0	0	0	1	4
2013	0	0	0	0	7
Total	103	81	43	52	681

[1]Includes those owls banded 1983-1989. The analysis for the DSA focuses on 1990-2013.

Appendix 2. Number of spotted owls detected within the Tyee Density Study Area (DSA), Roseburg, Oregon: 1990–2013.

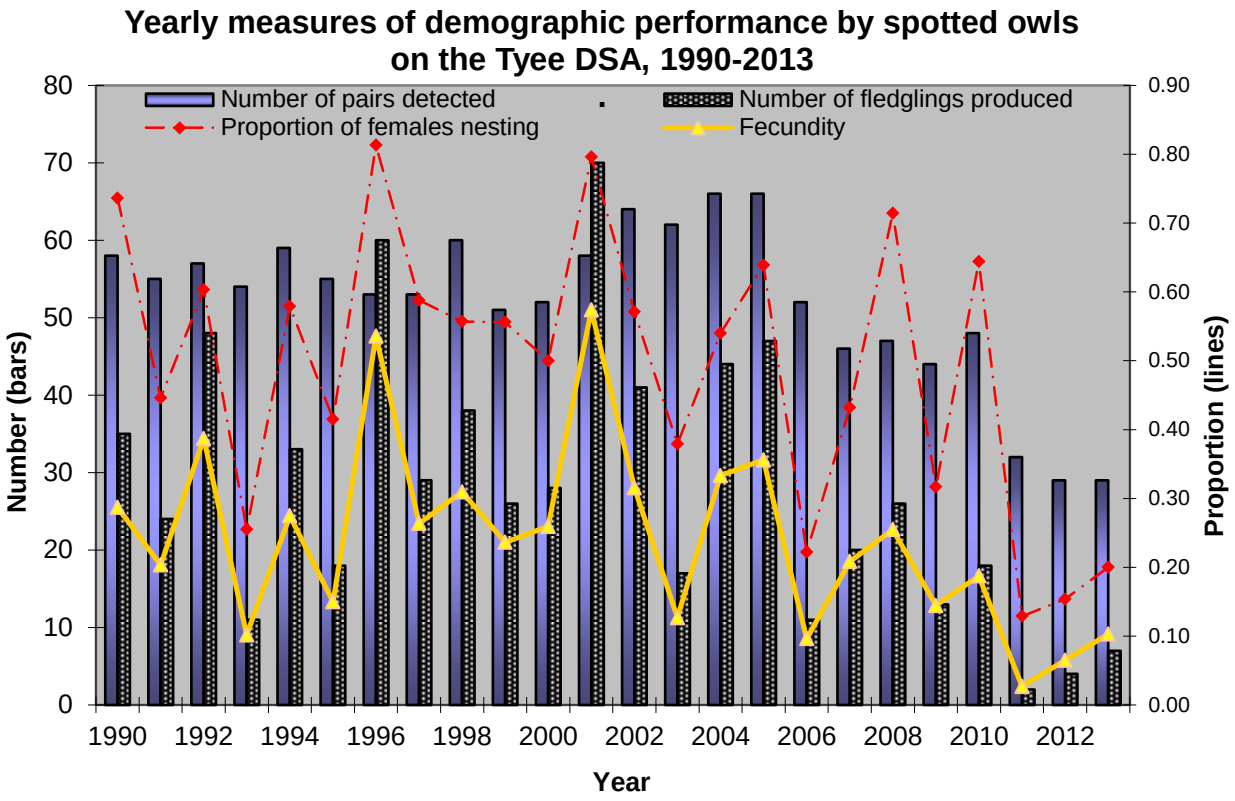
		Adults		1– 2-year-old		Age Unknown			Non-
Year	Pairs	Male	Female	Male	Female	Male	Female	Fledglings	Juveniles
1990	*58*	*61*	*49*	*7*	*10*	*7*	*8*	*35*	*142*
1991	*55*	*60*	*51*	*12*	*6*	*7*	*6*	*24*	*142*
1992	*57*	*60*	*52*	*10*	*8*	*4*	*5*	*48*	*139*
1993	*54*	*56*	*44*	*8*	*9*	*4*	*4*	*11*	*125*
1994	*59*	*60*	*51*	*10*	*9*	*1*	*2*	*33*	*133*
1995	*55*	*63*	*54*	*1*	*3*	*2*	*6*	*18*	*129*
1996	*53*	*56*	*51*	*5*	*5*	*4*	*2*	*60*	*123*
1997	*53*	*57*	*49*	*14*	*6*	*4*	*1*	*29*	*131*
1998	*60*	*53*	*46*	*18*	*14*	*5*	*4*	*38*	*140*
1999	*51*	*58*	*50*	*8*	*4*	*9*	*3*	*26*	*132*
2000	*52*	*57*	*53*	*5*	*2*	*5*	*3*	*28*	*125*
2001	*58*	*61*	*51*	*9*	*8*	*1*	*3*	*70*	*133*
2002	*64*	*60*	*48*	*17*	*17*	*3*	*1*	*41*	*146*
2003	*62*	*64*	*46*	*15*	*17*	*1*	*2*	*17*	*145*
2004	*66*	*73*	*60*	*4*	*5*	*1*	*2*	*44*	*145*
2005	*66*	*71*	*59*	*8*	*7*	*1*	*0*	*47*	*146*
2006	*52*	*58*	*50*	*10*	*9*	*2*	*0*	*11*	*129*
2007	*46*	*59*	*42*	*4*	*7*	*5*	*2*	*20*	*119*
2008	*47*	*63*	*43*	*9*	*8*	*2*	*2*	*26*	*127*
2009	*44*	*56*	*35*	*9*	*9*	*3*	*4*	*13*	*116*
2010	*48*	*51*	*42*	*13*	*6*	*1*	*0*	*18*	*113*
2011	*32*	*43*	*35*	*5*	*2*	*5*	*1*	*2*	*91*
2012	*29*	*43*	*31*	*0*	*1*	*1*	*3*	*4*	*79*
2013	*29*	*37*	*31*	*0*	*0*	*4*	*1*	*7*	*73*
AVG	*52.1*	*57.5*	*46.8*	*8.4*	*7.2*	*3.4*	*2.7*	*27.9*	*126.0*

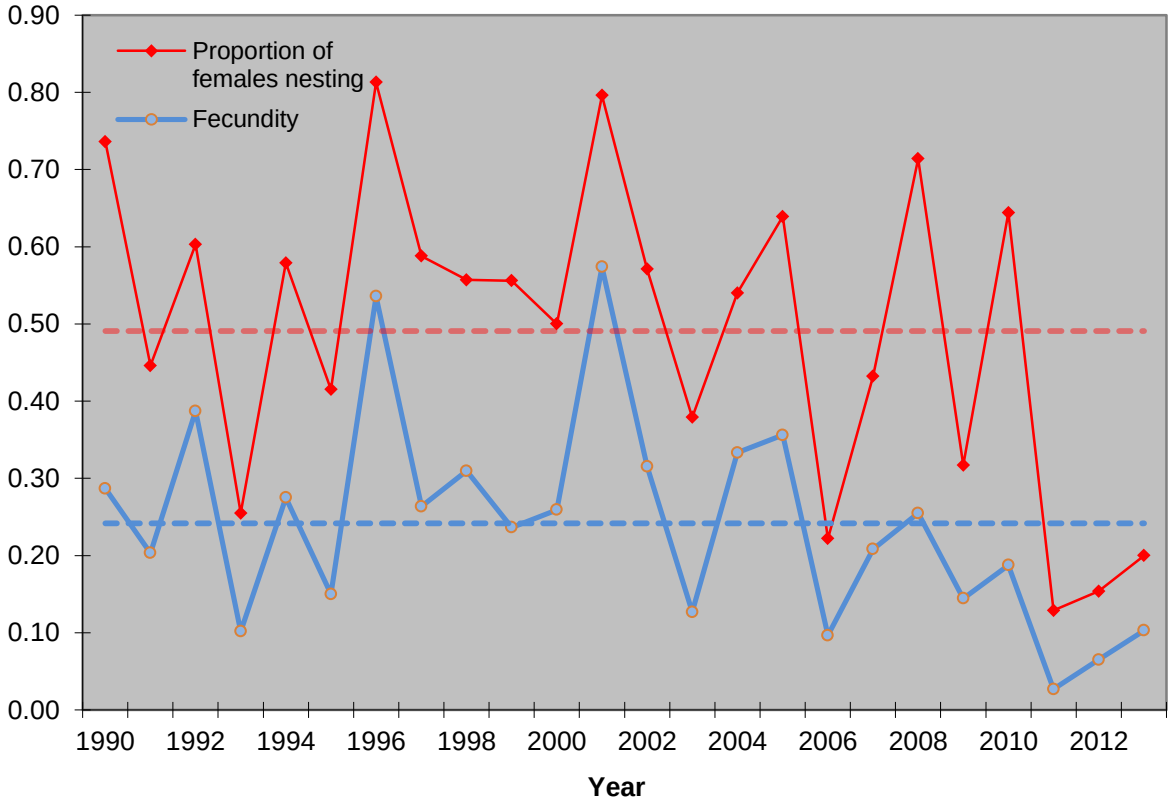
Appendix 3. Estimated fecundity and mean brood size of female spotted owls on the Tyee Density Study Area: 1990–2013. Fecundity was defined as the number of female young produced per female owl assuming a 1:1 sex ratio. Estimates were calculated for individual females for which reproductive output was documented by 31August.

	Fecundity[1]			Brood size[2]		
Year	N	Mean	SE	N	Mean	SE
1990	61	0.287	0.043	29	1.207	0.077
1991	59	0.203	0.050	14	1.714	0.125
1992	62	0.387	0.056	30	1.600	0.091
1993	54	0.102	0.038	7	1.571	0.202
1994	60	0.275	0.050	23	1.435	0.106
1995	60	0.150	0.042	12	1.500	0.151
1996	56	0.536	0.062	34	1.765	0.074
1997	55	0.264	0.055	18	1.611	0.118
1998	63	0.310	0.050	27	1.444	0.097
1999	55	0.236	0.050	18	1.444	0.121
2000	54	0.259	0.056	17	1.647	0.119
2001	61	0.574	0.061	39	1.795	0.075
2002	65	0.315	0.053	25	1.640	0.098
2003	67	0.127	0.034	13	1.308	0.133
2004	66	0.333	0.052	28	1.571	0.095
2005	66	0.356	0.054	29	1.621	0.092
2006	57	0.096	0.034	8	1.375	0.183
2007	48	0.208	0.051	14	1.429	0.137
2008	51	0.255	0.057	16	1.625	0.125
2009	45	0.144	0.049	8	1.625	0.183
2010	48	0.188	0.051	12	1.500	0.151
2011	37	0.027	0.027	1	2.000	N/A
2012	31	0.065	0.038	3	1.333	0.333
2013	29	0.103	0.052	4	1.500	0.289
Mean	**24**	**0.242**	0.028	**24**	**1.533**	0.030

[1] Fecundity was defined as number of female young produced per female. We assumed a 1:1 sex ratio for fledglings.
[2] Both fecundity and brood size were based on the number of young seen outside the nest tree, regardless of whether they were dead or alive.

Appendix 4. Annual estimates of selected demographic parameters for spotted owls, Tyee DSA, 1990-2013.





Appendix 5. Yearly comparison of the simple(annual report) method of deterining population trends and the complex analysis of the population stability modeling (lambda*) 1990-2013.
*The first and last estimates are confounded and not available from the model output.